SHIP PRODUCTION COMMITTEE
FACILITIES AND ENVIRONMENTAL EFFECTS
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INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

September 1981
NSRP 0008

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Proceedings of the REAPS Technical Symposium

Paper No. 7: A Management Simulator for Shop Stores in the U.S. Naval Shipyards

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
SEP 1981	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The National Shipbuilding Research Program Proceedings of the IREAPS Technical Symposium Paper No. 7: A Management Simulator for Shop Stores in the U.S. Naval Shipyards	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Surface Warfare Center CD Code 2230 - Design Integration Tools Building 192 Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**SAR**	**14**	

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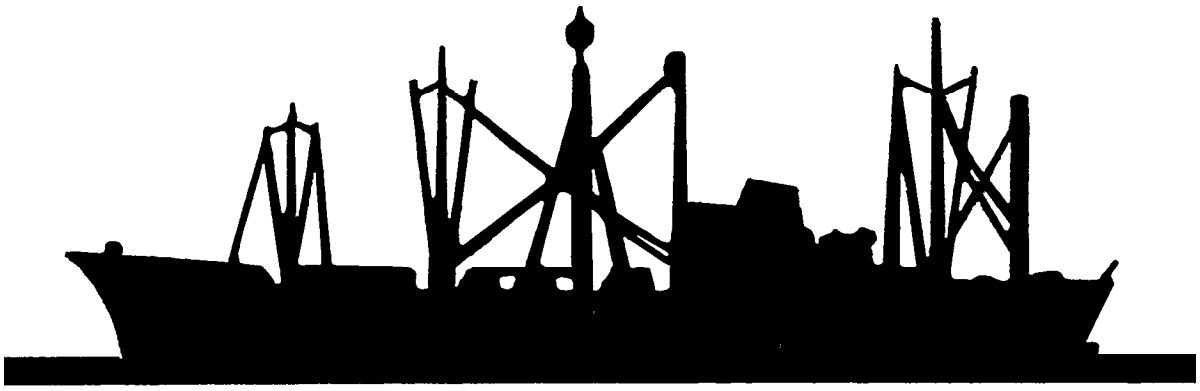
0008

Proceedings
IREAPS Technical Symposium
September 15-17, 1981
Baltimore, Maryland



INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

IREAPS

A MANAGEMENT SIMULATOR FOR SHOP STORES IN THE U.S. NAVAL SHIPYARDS

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ABSTRACT

In each of the eight Naval shipyards the part, of inventory referred to as shop stores contains between 15,000 and 40,000 stock keeping units with a combined value of between $9 and $20 million. In general, an item is carried in shop stores if some use for it is foreseen but the use cannot be tied to particular industrial projects. The makeup of shop stores is complicated by the nature of the financing and planning activities in the Naval shipyards.

For several years shap stores has been served by a package of computer programs with many sophisticated options. Among these options are management control parameters for changing reorder points and order quantities on a global basis. The parameters had not. been widely used until a pair of simulator programs gave inventory managers a means to link values of the control parameters with measures of performance.

The first simulator looks at individual shop stores items and allows them to be classified. Some items may not be appropriate for forecasting techniques, some may benefit from hand set reorder points and order quantities and others may best be given totally to computerized rules. The second simulator considers the totally computerized items and enables management to make the chosen tradeoffs in performance for these items as a group.

For the past four years I and others at California State University, Los Angeles have taken part in training programs aimed at improving the use of automatic inventory control techniques in the U. S. Naval shipyards. The underlying objective has always been better inventory management. Our focus has been on people who set policy and eva1uate results. New tools for getting information to these people have been designed as part of the training programs. The emphasis, however, has always been on effective use of automated procedures that were already available.

The Cal State Los Angeles training program has been supported by the Naval Sea Systems Command (NAVSEA) under the direction of its Management Systems Support Division (MSSD). NAVSEA has responsibility for construction, modification and maintenance of naval ships. MSSD oversees a number of activities including training and improvements related to the management, information system (MIS) in the naval shipyards. The eight naval shipyards are located in Portsmouth (New Hampshire), Philadelphia, Norfolk, Charleston, Bremerton (Washington), Mare Island (California), Long Beach (California) and Pearl Harbor. Almost all of our training program has been conducted at the shipyard sites.

The material used in the naval shipyards is divided into major groups for management put-poses. Two of these groups are direct material and shop stores. (Nuclear material will not be considered here.) Direct material consists of items carried to support specific production orders as written on Job Material Lists by the production planners. The Job Material Lists function as a partial Material Requirements Planning system (MRP). Shop stores exists to provide material which either is not identified or cannot be identified with specific jobs, particularly general usage items such as hardware, lumber, metals and so on.

There is great variety within shop stores itself. There are stock items used continually such as work gloves during production, and nuts and bolts which are physically added to the final product. There are also insurance items, such as spare crane parts. Items also vary by source of supply. There is standard material from the Naval supply system, and there are custom orders placed directly with vendors.

Automation of Naval Shipyard Inventories

During the 1960s a design for an integrated management information system (MIS) was laid out for the Naval shipyards. The modules of MIS, for payroll, job costing and so on, were adopted in the different shipyards over a period of years. By the early 1970s all eight shipyards had installed the MIS module for shop stores. This module remains in place with few modifications. It can perform a number of different tasks with an enormous number of options. The complexity of the shop stores package has led to both misuse and disuse.

In 1977, requests from the ship yards for explanations of the shop stores package lead to the first of several training contracts with Cal Sate University Los Angel es. In 1979 a group of summary reports called the shop stores Analyzer was added to the main package, and a prototype Simulator to answer what-if questions was constructed. The logic and the computer programs for both the Analyzer and the Simulator were developed at Cal State Simulator hardware and updated software for simulating performance of single stock items were actually delivered to the Naval shipyards in late spring 1981 during special two day training programs.

The MIS Shop Stores Package

The need for the shop stores Analyzer and Simulator and related training grew out of the design features of the original MIS shop stores package. The four basic features are:

1) Automated perpetual inventory records. This is a daily batch system for posting receipts, issues and orders.

2) Automated order writing. This is based on a reorder point and target order quantity for each stock item. Order writing is part of the daily batch run.

3) Statistics for each of the 15,000 to 40,000 stock items in shop stores. The statistics include physical usage, variability of usage, frequency of separate issues and leadtime.

4) Automatic review of reorder points and target order quantities. The review is done monthly based on the statistics of each item and a set of numeric control factors to be determined by the human manager.

In concept the original shop stores package incorporates most of modern theory for inventory automation. The working environment of the shipyards has been slow to digest and assimilate the theory.

There have been major problems with both input and output. Seemingly straight foward matters such as accurate and timely transfer of receipts and issues to data processing continue to require a great deal of clerical manpower. Perceived information needs have led to locally designed reports in many of the yards. The most critical problem has been lack of direction for the automatic features that are part of the shop stores system. The numeric control factors that govern the system were until recently an unused mystery.

There are five types of control factors available to the inventory manager. There is an order quantity factor which is related to the relative cost of processing orders for new stock versus the cost of holding stock on hand. This factor goes into an economic order quantity formula during the monthly review of stock items. Next come factors which set a minimum and maximum for target order quantities expressed in terms of so many months supply. These are the only factors whose numeric values have a meaning apart from the formulas they enter into. There is a risk factor which influences safety stock. Finally there is a leadtime factor.

Interaction between the control factors complicates their use. Some simplifications were uncovered by research into actual conditions in shop stores. For example, it turns out that any result accomplished by changing the leadtime factor can be gained more efficiently by other means. This means that the leadtime factors can be set to a nominal value and then ignored.

The action of the several control factors is further complicated by the existing shop stores classification system which includes Accounts (Active, Pre-expended Bin, Insurance, and others), Categories (something like the traditional A, B, C inventories) and Federal Supply Classes. Different classifications activate different combinations of control factors. In retrospect, the classification system was made too elaborate for conscientious control. In part, this was an attempt to incorporate all of the existing manual and computer systems for inventory.

The personnel structure of the supply departments in the Naval shipyards imposes limits on detailed experience. The Navy personnel are officers from the Supply Corps. They are skilled in general inventory management and have a good grasp of quantitative and computer methods. Yet they serve 1imited tours of duty in the Shipyard. Most of the civilian office personnel are clerks with on the job training. There are some very capable oldtimers, but few of these have authority or incentive to change the daily routine.

A Program for Managing Shop Stores

Meaningful changes must relate to accepted objectives. Defining a set of objectives which operating personnel will accept as their own should be the introduction to any new procedure. The objectives should be stated in general terms and in terms of specific measurements which will later be used for judging success. People will use new procedures when they see in them methods to achieve the objectives.

The general objectives of inventory management are good service, minimal workload and minimal investment. It is recognized that a balance must be struck between these three objectives; the balance should be a management decision at each point in time. The training program for the shop stores Simulator has presented these objectives in terms of a small number of measurements. The primary measurement for service is the hit ratio, which is the fraction of requests from production which can be filled immediately. The main measurement for workload is the number of separate orders for new stock made each year. Investment is measured by average dollar investment and by annual turnover.

The Analyzer-Simulator link between the original MIS shop stores package and the objectives comes in three parts. Current condition of the inventory is highlighted by the Analyzer reports with respect to demand, ordering, investment and inventory classification. The shop stores Simulator is the device for showing how the automatic features of the original package are governed by the numeric control factors. In other words, the Simulator shows how to go from current condition to the objectives. The third part of the link is the training program itself.

The complexity of the formulas in the shop stores MIS package dictated some form of computerized simulator. For example, the formula used in the monthly review of the reorder point for a stock item is

$$ROP = 1tf*ltd + Z\,C.\,006*rf*EOQ*UP/FREQ] * 1.\,25*LTMAD/30$$

where, in particular, 1tf is a leadtime factor, rf is a risk factor and EOQ depends on three other control factors. The other ground rules for

the Simulator included ease of use by supply personnel, minimal impact on the main shipyard computer and low cost.

The Simulator developed along the lines of training to prepare the user environment, software and hardware. The training, which is ongoing, concentrates on inventory objectives and the tools available for achieving the objectives. The Software split logically into a global simulator and a single item simulator. The global simulator estimates the overall impact of changes in the control factors for the inventory as described by current statistics. The global simulator is referred to as the central sector simulator since it excludes stock items whose extreme behavior makes them unsuitable for full automatic management. The single item simulator is used for quick testing of new management ideas and, more routinely, for systematically classifying items. Orderly classification is necessary for control.

From the user's point of View the single item simulator includes a keyboard for data entry and a video Screen. The display on the screen alternates between three electronic pages. Two of the pages are for input, one page for stock item characteristics and one for values of the control factors.. The third page summarizes the input and shows the estimated measurements of success with respect to the inventory objectives. The displays are Coupled with prompting messages to the user and online editing of all input amounts.

The electronic input page for stock item characteristics looks approximately as follows.

MONTHLY DEMAND IN UNITS------?
VARIATION IN DEMAND (MAD)----?
AVERAGE ISSUES PER MONTH-----?
LEADTIME IN DAYS-------?
SHOP STORES UNIT PRICE-------?

A cursor prompts entries for each characteristic and changes may be made selectively. The second page looks like

ORDER QUANTITY FACTOR----------?
MIN MONTHS SUPPLY FOR ORDERING--?
MAX MONTHS SUPPLY FOR ORDERING--?
RISK FACTOR FOR SAFETY STOCK----?
LEAD TIME FACTOR----------?

Once the two input pages are filled and edited the simulator calculates for about one second and then displays the output page. The main part of the output page looks like

hit ratio. 96. 3%	shorts/year. . 1. 44
average order $375.00	orders/year. . 8. 00
turns/year.. . . . . 9. 14	investment. $316. 00

The three lines correspond to the three inventory objectives of service, workload and investment.

The hardware for the Simulator was originally conceived as a custom built microprocessor with software in read only memory (ROM). In 1978 the estimated cost was $45,000 for 9 copies of the device. As de1ivered in 1981 the simulator hardware is an off the shelf microcomputer with software on diskette at a total cost of $20,000 for 9 copies. The lower cost shows the benefit of advancing technology. The equipment is also widely available, easy to maintain and versatile. These are qualities one would like to see in any inventory item.

Delivery and the initial training for the single item Simulator took place in May, 1981 for the east coast shipyards and in June, 1981 for the west coast shipyards. Conversations with the yards during July and August indicated the simulator was quickly put to use.

A Perspective on Automation

The benefits of the single item Simulator lie in a clear definition of objectives, its discipline for reviewing stock items and the link it provides between control and inventory performance. The progression from the original shop stores computer package to the Simulator is a reminder of how automation should be viewed. Objectives must be straight foward, measurable and well known. People must know how to use and control the automation available to them.